National University Science Parks in China and their Efficiency——analysis and implications for future strategies

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論 文 内 容 の 要 旨

In the end of last century, innovation economy is gradually taking the place of the traditional industrial economy. In this trend of new technology evolution, high-tech industries show great potential and gradually became a key factor of a nation's comprehensive strength.

Chinese economic strength was developing in an extremely high speed during the last few decades. In the 1980s, the national government began to establish a lot of Industrial Development Parks throughout mainland China. This pushed Chinese industrial economy to develop into a high growth rate. In order to keep this high growth rate, as well as promote economic restructuring, technology venturing activities are especially highlighted by the national government. Chinese government has undertaken substantial efforts to develop science parks to encourage innovation and technology transfer. In 1988, the Ministry of Science and Technology approved "Torch Plan"and "Spark Program", attaching great importance to industrialization of new and high technology. Driven by the science programs, province government, together with universities in China started to build science parks actively. Among the science university science parks, national university science parks,

which are based on strong scientific research strength of top universities, have been taken more and more seriously and quickly became the forefront of technology industrialization.

During the last twenty years, the development of the science parks provided a lot of valuable experience. Some of them played an important role in promoting technology and regional technology development. However, since Chinese university science parks started relatively late compared to developed countries, they are also facing many problems. System, policy, social environment and the participants can all cause problems to stop the UPSs from functioning efficiently. China is at a critical stage of economic restructuring and industrial upgrading. Under the pressure of international competition, national university Science Park is one of the most important ways of promoting technology transfer and high-technology industrialization. Through the development of NUSPs, we can make better use of the intellectual resources of universities and research institutions, therefore, put forward the development of high-tech industry and improve the international competitively of China.

Previous research has done a lot of work in studying science parks. Some of them focus on operating mechanism, process of academia-industry collaboration. While other researchers shows that start-ups inside a science park have an advantage in financing and management compared to others, and they have stronger technological background. Chinese researchers tend to study about the history, function, operating system and policy advice. As a whole, there is no systematizing and modeling research of University Science Park. Limited researches of performance evaluation usually focus on the design of evaluation system. Few of them process a further analysis based on the panel data and evaluation from both input side and output side. The most urgent problem right now is not how to narrow the difference gap between ordinary parks with outstanding ones, but how to make ordinary ones more efficient under a limited situation in aspects like incubating new business and promoting regional economic growth. This research is based on six year's statistic data of all the National University Science Parks. We take Data Envelopment Analysis to evaluate the efficiency of the parks. Instead of compare all of the science parks with one typical successful one, we would like to know the relative performance among all the NUSPs. We take both input and output into account, and try to make sure how to improve the performance of a science park with limited input resources.

Data Envelopment Analysis (DEA) is a multiple inputs -multiple outputs evaluation method applied in this research to evaluate the efficiency of National University Science Parks in China. Another advantage of this method is that it can combine many measures without setting a priori weight for the various parameters to produce an overall efficiency measure. We will apply DEA theory to analyze the efficiency of National University Science Parks. The outcome will be divided into two categories to conduct further analysis. The following briefly describes the models we will use in the analysis.

This thesis will firstly calculate the relative efficiency of all the National University Science

Parks in China from 2008 to 2013. We apply CCR model to obtain the total technical efficiency, while use BCC model to obtain pure technical efficiency and scale efficiency. According to the results, the NUSPs will be classified and we will pick up typical cases and describe them in detail. We consider all science parks from two dimensions, one is pure technology efficiency, and the other one is scale efficiency. According to the pure technology efficiency and scale efficiency calculated, we would like to divide NUSPs into four categories. The average of the two dimensions divides the coordinate system into four quadrants. University Science Parks located in area B show relatively higher efficiency than other parks. Area C shows both inefficient in PTE and SE. NUSPs in Quadrant A mainly have problem in resource allocation, daily operation, and other improper management activities. While those located in Quadrant D shows scale inefficiency. We further calculated the returns to scale of the science NUSPs. A park with increasing return to scale might try to expand and make full use of its resource. On the contrast, a park with decreasing return to scale should consider reduce its scale and lower management cost.

The six-year data shows that over 75% of the NUSPs were getting more and more inefficient. Despite of National Science Park of Zhejiang University and National Science Park of China University of Petroleum who remain perfect efficiency from 2008 to 2013, National Science Park of Nanchang University is the only park shows a rising trend. Another special case is Tsinghua University Science Park; the park keeps a high technology efficiency and oversized scale with a decreasing return to scale.

Regardless of the efficiency, if we only consider input resources or output achievements, National Science Park of Tsinghua University is absolutely one of the best science parks in China. Its success cannot be realized without venture capital operation of TusPark Ventures. Tsinghua Science Park provides advantageous software and hardware environment for ventures and truly combined venture capital and incubating activities. The parks built a network with university, government, high-tech companies and financial institutions. The TusPark Venture acts like an important link in this network. TusPark Venture also has its own financing process in daily operating. The management team of TusPark Venture is built upon the intellectual advantages of Tsinghua University. This team owns a lot of experienced managers in high-tech industries. Some of them are back from the United States. They brought in their experience and knowledge into TusPark Venture and trained fellows in the past few years. Compared to other Science Parks, TusPark Venture are more like to invest in companies in the start-up stage. In the data we mentioned earlier, 76% of the tenants are in the start-up stage. This percentage is much higher than other University Science Parks but is more in line with the purpose of setting up National University Science Parks.

Another significant case is National University Science Park of Nanchang University. The background of the park is relatively weak in both economic aspect and academic aspects. However, it is the only NUSP showing a growing efficiency during the six years. As the only National Science Park

in the province, Nanchang Science Park monopolized all the province resources for a long time. At the same time, it built a virtual network connecting the whole province's 95 county level industrial parks and provides technology support. This is a very reasonable and convenient way to gather and distribute resources. Another key successful factor is that the park takes technology transaction seriously. In 2007, Nanchang University Park built a technology trade market, which is the only equity trade market established by a university science park. It supplies information about new scientific achievements, patents, high-tech talents, scientific instruments and enterprise demand. People can search and buy the technologies easily compared to the traditional methods. This idea greatly accelerated the technology transfer process.

On the basis of the analysis and two case studies and considering the issue of new policy, we suggest that in the near future, the rearrangement of innovation system should be considered in China. We further put forward some relative policies that might be taken into account.

As a whole, our research evaluates National University Science Parks in the view of efficiency and offers explanation for the differences between high performance and normal performance. In addition, both cases show meaningful radiation effect in a different range. This might be an alternative despite of the capital market and technology market development.

論 文 審 査 結 果 の 要 旨

本論文は、国家的なNational Innovation Systemの重要な部分をなす中国の国家級大学サイエンスパーク(＝National University Science Park、以下NUSPという)の効率性を確認し、
今後の政策に資するための方策を提言することを目的としている。

第一章では中国の科学技術政策についての説明、第二章では研究の背景と既存研究のレビューがなされる。筆者は、既存研究はこれまでNUSPに対する評価は、最も成功しているといわれている中関村のNUSPとの比較しそのギャップを如何に埋めるかという視点を採用するものが多いが、これではNUSP に本来求められる機能が明らかにならないとし、代わりに地域におけるハイテク産業形成にNUSPがどの程度寄与したのかという視点で各NUSPを評価する必要があることを指摘する。

第三章、第四章ではこの課題に取り組むために、包絡分析法(＝Data Envelopment Analysis 、以下DEAという)を用いて、各NUSPの効率性を測定することを試みた。DEAの入力項目として、NUSPの雇用者数、インキュベーション向け資金額、面積、大学の研究能力の5項目を、出力項目としては、卒業企業数、入居企業数、入居企業の雇用者数、年間総収益額の 4 項目を取り上げた。これらの項目について、2008年から2013年までの6年間を対象にして、NUSPの継続性を考慮しつつ、データ収集を行い、まず年次ごとにDEA分析を行い、さらに技術と規模の要因分析(BCC Model)を行い、年次的変化をみて、各NUSPのグルーピングを行った。さらにDEAの時系列分析では、年度ごとのフロンティアの変動により、効率性が偏倚する問題点があることを踏まえて、この点については Malmquist

分析によって、偏倚を修正しても、時系列の変動に差異が生じない点を検証した。分析の結果、2011年に大きな変化要因が生じていたこと、及びこれまで成功事例としてベンチマークとされた中関村の清華大学の NUSP の効率性がそれほど高くないことが明らかにされ、その理由が考察された。

第五章では事例研究が行われ、清華大学、浙江大学、南昌大学の NUSP がケース分析され、地域との連携によるネットワークを通じた技術、人材、資金などの資源調達が効果を持った点が指摘された。最後に、上記分析を踏まえた結論と実務的なインプリケーションが提示された。よって、博士（経営学）の学位請求論文としての審査は合格とする。